1019-26 Reduced Feasibility of Mitral Repair and Greater Risk of Failed Repair in Anterior Leaflet Prolapse or Flail

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Mitral valve repair and replacement (MVR) are effective treatments for mitral regurgitation (MR) from prolapse (MVP) and/or flail. Mitral repair preserves LV function and avoids anticoagulation but is not always feasible. To assess whether the location of mitral leaflet prolapse or flail impacts the feasibility of mitral repair, we examined pre- and postop (4–10 days) transthoracic echoes (TTE) on 203 consecutive surgical pts (mean age 60 ± 14 years, 64 women). Pts were separated by which leaflet had prolapse or flail (anterior, posterior, or bileaflet). No pt with bileaflet involvement had anterior flail. Age, gender, preop LV and LA dimensions were not significantly different among the three groups. All pts (3%) with immediate failure of repair had a 2nd pump run for further surgery.

	Anterior leaflet n = 39	Posterior n = 103	Bileaflet n = 61	Total n = 203
% Flail	49	85	57	72
% Repair	59*	89*	87*	83
% 2nd pump	7.5	1.9	0	2.5

*p< 0.005

The 3 groups (or repair vs MVR) did not differ in reduction in LV (62.7 ± 8.5 to 53 ± 13 mm, $p < 0.001$) and LA size (54 ± 11 to 46 ± 13 mm, $p < 0.001$) after surgery. Any flail (vs no flail) increases repair feasibility (85% vs 71%, $p = 0.01$).

Conclusion: The feasibility of repair is higher for bileaflet (87%) or posterior (90%) than anterior leaflet prolapse or flail (59%), $p < 0.005$*; and is higher in flail than prolapsing leaflets. 2. Anterior leaflet flail or prolapse has higher risk of immediate failure after attempted mitral repair.

1019-27 Patient Controlled Analgesia Post Cardiac Surgery Results in Shorter Hospital Stays

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Despite the easy accessibility and common use by orthopedic and gynecologic surgeons, physicians caring for postoperative cardiac surgery pts have been extremely reluctant to prescribe pt controlled analgesia (PCA) pumps for their pts. The major concerns expressed were respiratory depression, overdosing, inadequate pain control, and loss of "control" by the physician/nursing staff.

Sixty pts who were scheduled to undergo myocardial revascularization were selected and asked to participate in the study. Thirty were used as controls and received standard postoperative pain management. Thirty (age, sex, & procedure matched) subjects were asked to use the PCA pump postoperatively. Five pts in each group were "redo" surgeries.

Amount of MSO4 used during consecutive eight hour periods beginning four hours after endotracheal extubation

	1	2	3	4	5	6	7
Control Group	12 mg	8 mg	10 mg	pills	pills	pills	pills
PCA Group	7 mg	6 mg	6 mg	5 mg	5 mg	4 mg	3 mg

Average length of hospital stay for the control group was 7.2 days, while it was 5.8 in the PCA pump group ($p < 0.1$). The reasons for earlier discharge were earlier participation in rehab, less nausea from decreased use of oral pain meds, better pain control, and less atelectasis and pulmonary infiltrates on CXR. Cost of hospital stay was significantly less in the PCA group ($p < 0.01$). The major difficulty with this approach to postoperative pain management is reorientation of both the physician and nursing staff. Only one pt had a complications of over sedation with the PCA pump, because of family interference.

Overall, pts can be managed with PCA pumps post cardiac surgery safely, with less cost, and greater pt satisfaction than by the current standard of IV MSO4 and pain pills administered by a nurse.

1019-28 Retrograde Cardioplegia Increases Diastolic Chamber Stiffness After Coronary Artery Bypass Surgery

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We have previously shown that diastolic dysfunction is frequent immediately after CABG. Although combined antegrade and retrograde cardioplegia (A + R) may improve myocardial protection, it can also lead to extracellular edema and microvascular injury. To assess postCABG diastolic function after A + R cardioplegia, volume manipulation was used to create pressure-area curves before and after CABG in 20 pts. LV end diastolic area (EDAREA) was measured by transesophageal echocardiography as an index of end diastolic volume, and plotted against the PCWP as an estimate of mean LV diastolic pressure. A smaller EDAREA at a similar PCWP postCABG reflects a leftward shift in the pressure-area curve and increased LV diastolic chamber stiffness.

	A (n = 14)	A + R (n = 6)	p
EF(%)	52 ± 4	56 ± 4	NS
Wall thickness (mm)	9.9 ± 0.1	9.3 ± 0.3	NS
Bypass (min)	80 ± 5	74 ± 7	NS
Pre-Post ΔPCWP (mmHg)	1 ± 1	0 ± 1	NS
Pre-Post ΔEDAREA (%)	−12.4 ± 2.3	−22.5 ± 3.0	0.02

Increased LV diastolic chamber stiffness occurred in all pts postCABG, but was more pronounced with both antegrade and retrograde cardioplegia.

Conclusion: After CABG, combined A + R cardioplegia is associated with a more prominent increase in diastolic chamber stiffness than antegrade cardioplegia alone. Recognition of worsening diastolic function with A + R may be important for optimal pt management postCABG.

1019-29 Resection vs PTFE Chordal Replacement for Repair of Mitral Valve Insufficiency

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Traditional management of prolapsing leaflets involves leaflet resection ± native chordal repair. Uncertainty exists as to the role of chordal replacement with PTFE sutures. We compared the outcome of repair in 108 pts, 56 (52%) with #5 PTFE chordae (C) and 52 (48%) with resection (R). Both C & R had Puig-Massana ring annuloplasties. Mean age was 61 ± 16 yrs, 53 were male (49%) and 79% of pts were NYHA III or IV. Sinus rhythm was present in 75 (69%) pts, atrial fibrillation in 25 (23%). Etiology was myxomatous: 68 (63%), rheumatic: 13 (12%) ischemic: 12 pts (11%). Other valve replacement ± CAB were performed in C 16 (29%) pts, R 27 (52%) ($p = 0.0132$). Clamp time was 56 ± 23 min. for C, 61 ± 28 min for R (p = NS), bypass time 78 ± 30 and 84 ± 30 min (p = NS). Mortality (30 day) was CR 1/56 (1.8%), R 3/52 (5.8%) (p = NS). Post-op, mitral regurgitation was absent/mild in 104 (96%) pts, for CR 53 (95%), R 51 (98%) (p = NS). Predischarge mitral valve gradient was for CR, 2.45 ± 1.78 mm and RT 2.73 ± 2.45 mm (p = NS). At follow-up of up to 5 years, 96% of pts were NYHA I or II. Reoperation was required in C 1/56 (2%) R 4/52 (8%), p = NS. Thus use of C produced results similar to R. C repair can be used in all pts with mobile leaflets and mitral regurgitation, especially when both anterior and posterior leaflets are involved.

1019-30 The Effects of Protamine Sulfate on Myocyte Sarcolemmal Processes and the Relationship to Contractile Function

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Protamine sulfate (PROT), a polycationic peptide is used to reverse the anticoagulant effects of heparin in cardiovascular operations but has been associated with acute LV dysfunction. We hypothesized that the cationic nature of PROT would alter myocyte (MYO) contractile processes, sarcolemmal function (Na^+, K^+-ATPase) and electrophysiology. Accordingly, isolated MYO contractile function (velocity of shortening; VEL,μm/s) from 6 pigs was measured in the control state (no PROT) and in the presence of PROT (40 or 80 μg/ml; clinical doses of 2.5 and 5 mg/kg). Baseline (BASE) MYO VEL was obtained and then repeated following inhibition of the Na^+, K^+-ATPase with 2 μM ouabain (OUAB). In addition, indices of MYO membrane potential (resting, RMP; max upstroke velocity, Vmax; time to 90% repolarization, APD_{90}) were measured in the control state and in the presence of PROT.

	BASE-VEL	OUAB-VEL	RMP (mV)	Vmax(V/s)	APD_{90}(ms)
CONTROL	48 ± 2	65 ± 6$^+$	−79.1 ± 0.8	139 ± 5	163 ± 9
40-PROT	31 ± 2*	32 ± 3*	−73.7 ± 1.1*	130 ± 5	214 ± 18*
80-PROT	27 ± 1*	28 ± 4*	−73.0 ± 2.1*	114 ± 5*	219 ± 6*

*$p < 0.05$ vs Control, $^+p < 0.05$ vs BASE

Na^+, K^+-ATPase OUAB binding (Ba; pmol/mg), affinity (Kd; nM) and hydrolytic activity (ACTIVITY; μgpNP/mg/hr) were measured in the control state and with 40 μg/ml PROT. *Summary:* PROT altered Na^+, K^+-ATPase receptor binding but not hydrolytic capacity. Thus, the mechanism for changes in MYO function and electrophysiology is likely due to alterations in sarcolemmal conformation. These results provide a potential cellular mechanism responsible for the acute LV dysfunction associated with PROT administration.

	Ba	Kd	Activity
Control	7.1 ± 1.5	20.6 ± 2.3	0.8 ± 0.2
40-PROT	2.6 ± 0.4*	38.5 ± 1.5*	0.6 ± 0.1

1020 New Echo-Doppler Methods for Quantitating Regulation

Wednesday, March 22, 1995, 3:00 p.m.–5:00 p.m.
Ernest N. Morial Convention Center, Hall E
Presentation Hour: 3:00 p.m.–4:00 p.m.

1020-1 A New Method of Accurate Quantitation of Aortic Regurgitation Using Doppler Echocardiography

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Estimation of aortic regurgitation (AR) by Doppler echocardiography (DE) may not correlate with cath, especially for inte mediate grades (II, III) of AR. The volume of the AR can be estimated as the product of the jet cross-sectional area (JCSA) and the velocity time integral (VTI) of the AR jet. The purpose of this study was to determine the correlation of JCSA x VTI with AR grade at cath and to compare this with widely used method of jet-height to left ventricular outflow tract diameter ratio (JH/OTD). We analyzed 58 consecutive patients with AR who had both DE and contrast aortography. The maximal height of the AR jet on color flow Doppler was measured in the parasternal long axis view at the junction of the aortic annulus and LV outflow tract. JCSA was calculated as $\Pi(JH/2)^2$. VTI was measured as the area under the continuous wave Doppler tracing of AR obtained from the apical view. Severity of AR on aortography was graded on a I–IV scale.

JCSA x VTI Grades \ AR Grades by Cath	I	II	III	IV	Range of JCSA x VTI grades
I	19	2	1		[3.5 - 40]
II	2	11	1		[45 - 79]
III		1	10	1	[79-150]
IV			1	9	>190

Results: The correlation (Spearman's rank, r) of JCSA x VTI with the AR grade at cath was superior to JH/OTD: 0.88 vs 0.77, p = 0.02. The Table shows the relationship between the 4 grades of AR by cath vs JCSA x VTI (derived retrospectively). The accuracy of JCSA x VTI for grades II and III AR was 89% and 74% respectively, while the accuracy of JH/OTD for the same was 78% and 69% respectively (p = 0.04 and p = 0.05).

Conclusion: The JCSA x VTI product is an easily obtained index of aortic regurgitant severity that closely correlates with AR grade obtained at cath. It is superior to JH/OTD for quantitation of AR, especially for intermediate grades of AR.

1020-2 Evaluation of Aortic Regurgitation (AR) Using Color Doppler Jet Measurement: An Animal Study with Quantified AR

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Although the color Doppler (CD) jet width and area measurement methods have been widely used clinically for evaluating the severity of aortic regurgitation (AR), there have been no studies comparing CD jet measurements with a strictly quantifiable reference standard for determining regurgitant volume. The purpose of the present study was to evaluate the accuracy of the CD jet area planimetry, jet length and jet *neck* width measurement methods for quantifying chronic AR. In 6 sheep, 3 with partial resection of the right coronary cusp and 3 with partial resection of the non coronary cusp to produce chronic AR, 21 hemodynamically different states were obtained pharmacologically 20 weeks 20 weeks recovery. AR jet length and area and the width of the imaged flow connection between the flow acceleration field and the expanding regurgitant jet, which we call the *jet neck* at its smallest diameter were imaged and measured using a Vingmed 775 scanner. The peak and mean regurgitant flow rates (RFR), regurgitant stroke volumes (RSV) and regurgitant fractions (RF) were determined using pulmonary and aortic electromagnetic flow probes and meters balanced against each other. Results using simple liner regression analysis between the CD jet data and hemodynamic data were as follows.

	Peak RFR	Mean RFR	RSV	RF
AR jet area	r = 0.66	r = 0.74	r = 0.67	r = 0.68
AR jet length	r = 0.40	r = 0.51	r = 0.46	r = 0.46
jet neck width	r = 0.88	r = 0.95	r = 0.97	r = 0.89
jet neck/LVOT	r = 0.84	r = 0.91	r = 0.94	r = 0.89

LVOT; Left Ventricular Outflow Tract

Our study shows that the CD jet area and length methods have limited use for determining AR severity, and that the jet neck *width* method, either with or without normalization for LVOT size depending on patient population studied, should be most accurate for evaluating severity of AR.

1020-3 Evaluation of Aortic Regurgitation Using Digitally Determined Color Doppler Imaged Flow Convergence Acceleration: A Quantitative Study in Animals

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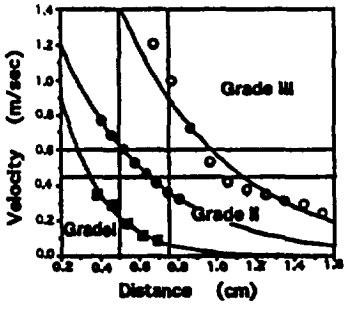
To evaluate a flow convergence (FC), axial centerline velocity/distance profile method as applied to chronic aortic regurgitation (AR), we compared FC results to AR flow rates and volumes simultaneously determined by aortic and pulmonary electromagnetic flow probes and meters (EM) balanced against each other. In 6 sheep, a total of 21 hemodynamic states were obtained 20 weeks after the original surgery to produce AR. Echo studies were performed to obtain complete axial FC velocity/distance profiles from apex views. The color Doppler velocity data were directly transferred in digital format from the ultrasound instrumentation to a microcomputer. AR was classified as grade I when the peak AR flow rate was <2.5 l/min (7 conditions), as grade II when it was between 2.5 and 6.0 l/min (5 conditions), and grade III when it was >6.0 l/min (9 conditions). All of the velocity/distance acceleration curves toward the AR orifice showed organized acceleration fields with highly significant correlations using multiplicative regression fits ($y = ax^{-b}$; r = 0.94–0.99; all $p < 0.01$). All of the centerline velocity/distance profiles for grade III regurgitation traversed a domain encompassed by velocities >0.6 m/sec at distances from the orifices >0.75 cm; the profiles for grade I regurgitation resided in a domain encompassed by velocities <0.45 m/sec at distances from the orifices, <0.5 cm. The profiles for grade II regurgitation resided in a domain between these. In addition, an equation for correlating both "a" and "b" (coefficients) with the peak AR flow rates (Q l/min) was derived from multiple regression analysis (Q = 16a + 1.5b – 1.5, r = 0.95, p < 0.001, SEE = 0.55 l/min). This study, using quantified AR, demonstrates that the FC axial centerline velocity/distance profile method can be used for evaluating the severity of aortic regurgitation.



1020-4 Proximal Isovelocity Surface Area Method Applied to Non-Planar Surfaces: Implications of In Vitro Studies for Clinical Regurgitation and Stenosis

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The color Doppler *proximal isovelocity surface area* (PISA) method accurately estimates volume flow rate (Q) across a planar surface *in vitro*. This method has been applied clinically to estimating valvular regurgitant flow using a hemispherical formula requiring measurement of a single axial radius. However, since cardiac valves may approximate convex shape, the most accurate